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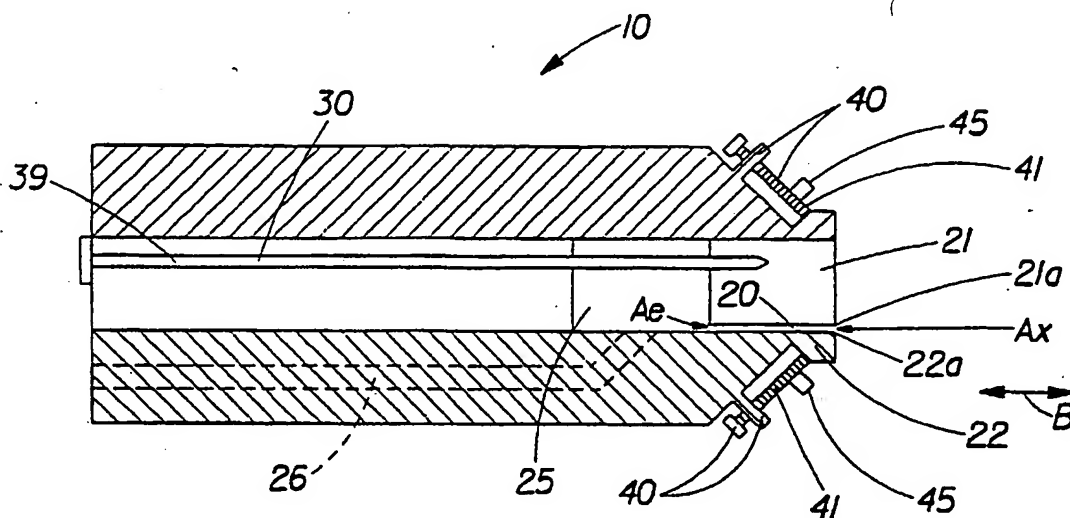
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(54) Title: **DIE HEAD HAVING MOVABLE LIP**



(57) Abstract: A die head (10) for extruding a chemical additive comprises an interior channel (25) for receiving the chemical additive and a pair of mutually opposite discharge lips (21, 22) forming at least one discharge mouth (20) therebetween, which discharge mouth (20) is in fluid communication with the interior channel (25). At least one of the discharge lips (21, 22) is movable relative to the other in a direction substantially parallel to the movement of the chemical additive through the discharge mouth (20). By reciprocally moving the discharge lip (21), one can remove contamination build-up in the discharge mouth (20).

WO 01/12414 A1

DIE HEAD HAVING MOVABLE LIP

FIELD OF THE INVENTION

The present invention generally relates to extrusion processes and apparatuses therefor. More specifically, the present invention is concerned with processes and apparatuses for extruding chemical additives onto substrates, such as those used in making disposable items, such as paper toweling, napkins, toilet tissue, facial tissue, etc.

BACKGROUND OF THE INVENTION

Die heads for depositing a chemical additive onto a substrate are known in the art. Dies of a type generally known in the art as a coat-hanger die are described, for example, in the following U. S. patents: 4,043,739 issued on August 23, 1997 to Appel and assigned to Kimberly-Clark Corporation; 4,372,739 issued on February 8, 1983 to Vetter et al. and assigned to Röm GmbH of Darmstadt, Germany; 5,234,330 issued on August 10, 1993 to Billow et al. and assigned to Eastman Kodak Company; 5,494,429 issued on February 27, 1996 to Wilson et al. and assigned to Die heads, Inc. Several other types of extrusion apparatuses are disclosed, for example, in the following U. S. patents: 5,607,726 issued on March 1997 to Flattery et al.; 5,522,931 issued to Iwashita et al. on June 4, 1996; 5,740,963 issued to Riney on April 21, 1998; 5,511,962 issued to Lippert.

One of the concerns relating to die heads of prior art has been plugging of a die's discharge mouth, i. e., the outlet through which the extrudate, such as, for example, a chemical additive, exits the die head. Die heads are frequently used in dusty environments. In papermaking, for example, some paper webs tend to be particularly prone to release surface fibers. A dust comprising primarily papermaking fibers may cause

contamination of a chemical functional additive, such as, for example, a topical tissue softener, which is routinely extruded onto the paper web. Other common contaminants may include degradation products of the chemical additive itself, which particularly may occur in stagnant areas around the walls of the die head. Build up of these degradation products can form over a period of time, harden and eventually separate from the walls of the die, thereby becoming a contaminant. More generally, particulate soil, sand, dirt, and grit tend to become airborne in the vicinity of the extrusion operation and settle into the supply of the chemical additive feeding the die head.

If the chemical additive, such as, for example, softener, is deposited onto a substrate by extrusion, the contaminants, which have found their way into the softener being extruded, may with time build up therein and eventually plug the discharge outlet of the die head. A process of cleaning of the die heads is usually costly, because it involves stoppage of a production line and/or a substantial effort. The cleaning may be further complicated in die heads designed to extrude very thin layers of extrudates and therefore comprising the discharge mouths having very small (in the range of 0.0002-0.00450 inches) dimensions requiring maintenance of high-precision tolerances.

Accordingly, the present invention advantageously provides a novel die head structured to allow one to quickly and efficiently remove the contamination build-ups from the discharge mouth. The present invention also provides an advantage of an extrusion process which substantially eliminates plugging of the discharge mouth of the extrusion apparatus.

Other objects, features, and advantages of the present invention will be readily apparent from the following description taken in conjunction with accompanying drawings, although variations and permutations may be had without departing from the spirit and scope of the disclosure.

SUMMARY OF THE INVENTION

The present invention provides a die head and a process for applying an extrudable material onto a surface of a web substrate or other working surface. A preferred extrudable material comprises a chemical additive commonly used in making consumer-disposable articles, such as paper toweling, napkins, toilet tissue, facial tissue, sanitary napkins, diapers, etc. The chemical additive may comprise a functional composition (i. e., the composition influencing strength, softness, or absorbency), or aesthetic composition (i. e., the composition conveying aesthetic impression, such as, for example, color, fragrance, and the like), or a combination thereof. The chemical additive is preferably selected from the group consisting of softeners, emulsions, emollients, lotions, topical medicines, soaps, anti-microbial and anti-bacterial agents, moisturizers, coatings, inks and dyes, binders, and fragrances. The preferred chemical additive of the present invention comprises a chemical softening composition. More preferably, the chemical softening composition comprises quaternary compounds having the formula: $(R_1)_{4-m} - N^+ - [R_2]_m X^-$, wherein m is from 1 to 3; each R_1 is a C_1 - C_6 alkyl group, hydroxyalkyl group, hydrocarbyl or substituted hydrocarbyl group, alkoxyalkyl group, benzyl group, or mixtures thereof; each R_2 is a C_{14} - C_{22} alkyl group, hydroxyalkyl group, hydrocarbyl or substituted hydrocarbyl group, alkoxyalkyl group, benzyl group, or mixtures thereof; and X^- is any softener-compatible anion.

A preferred web substrate comprises a fibrous web, such as, for example, a paper web. It is to be understood, however, that the die head and the process of the present invention may be beneficially used with other types of the extrudable fluids, such as, for example, polymer melts or

adhesives, and other types of the substrates, such as, for example, non-wovens. The die head and the process of the present invention may also be used to form extrudates free of an underlying substrate, as, for example, a polymer film.

The die head of the present invention has an interior channel for receiving the chemical additive, and comprises a pair of mutually opposite discharge lips forming therebetween at least one discharge mouth in fluid communication with the interior channel. At least one of the discharge lips is movable relative to the other in a first direction substantially parallel to the movement of the extrudable material through the discharge mouth. The discharge lip is movable by a lip actuator in operable communication therewith. In one embodiment, the lip actuator comprises a screw. In another embodiment, the lip actuator comprises a piston driven by hydraulics or pneumatics. The lip actuator may also comprise a variety of devices known in the art. For example, it can be driven by a spring or by thermally expanding or contracting elements using heating or cooling devices. Other examples of the lip actuator include those comprising a cam mechanism and devices using application of an energy field, such as, for example, a magnetic field.

The die head may have the discharge mouth which is flared in at least one cross-section. Preferably, the discharge mouth is flared in at least two mutually perpendicular cross-sections. The preferred discharge mouth has a substantially circular shape.

The die head may have a plurality of discharge mouths consecutively spaced one from the other, or alternatively – one elongated discharge mouth. The die head may further have one or plurality of lip persuaders in operable communication with at least one discharge lip, for moving the lip in a second direction substantially different from the first direction. One preferred lip persuader comprises a screw. Another preferred lip persuader

comprises a heating device inducing a change in position by selectively thermally expanding the elements of the persuader. The screw lip persuader and the heating means may be combined to provide coarse and fine adjustments.

In one preferred embodiment, the die head further comprises a knife-edge tip formed by at least one of the discharge lips. More preferably, the knife-edge tip is formed by two converging outer surfaces of the discharge lips.

The process of the present invention comprises the following steps:

- (a) providing an extrudable material;
 - (b) providing a die head of the present invention described herein above;
 - (c) extruding the material through the discharge mouth of the die head;
- and
- (d) moving, from time to time, at least one of the discharge lips, thereby removing contamination build-ups in the discharge mouth.

The process further preferably comprises the step of providing a working surface and continuously moving the working surface in front of the discharge mouth of the die head, whereby the step (c) further comprises depositing the extrudable material onto the working surface. The working surface is preferably the surface of the web substrate or the surface of the roll which will later in the process contact the surface of the web and thereby transfer the extrudable material thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional side view of a die head of the present invention, having a moving lip.

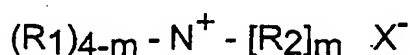
- FIG. 2** is a schematic cross-sectional side view of another embodiment of the die head of the present invention, having a knife-edge discharge tip.
- FIG. 2A** is a partial and schematic cross-sectional side view of an embodiment of a lip actuator comprising a cam mechanism.
- FIG. 2B** is a partial and schematic cross-sectional side view of an embodiment of the lip actuator comprising an electromagnetic device.
- FIG. 3** is a schematic representation of a process using the die head of the present invention.
- FIG. 4** is a schematic frontal view of the die head shown in FIG. 1.
- FIG. 5** is a schematic frontal view of another embodiment of the die head having a plurality of discharge mouths.
- FIG. 6** is a schematic partial view similar to that shown in FIG. 5, showing another embodiment of the discharge mouth having a plurality of discharge mouths.

DETAILED DESCRIPTION OF THE INVENTION

A die head **10** of the present invention comprises a body having an interior channel **25**, best shown in FIGs. **1** and **2**, for receiving an extrudable material. As used herein, the term "extrudable material" includes any substance, preferably liquid, which can be forced under pressure through the extrusion die of the present invention, resulting in an extrudate. Preferred extrudable materials comprise a "chemical additive", a term which, as used herein, refers to substances that may be added to the paper web to improve the web's functional and/or aesthetic characteristics, such as, for example, softness, strength, absorbency (functional characteristics) or inks and dyes (aesthetic characteristics). The chemical

additives include, but are not limited to fluid comprising: water; alcohol; softeners (polysiloxanes, cationic surface active agents including quaternary ammonium compounds, non-cationic surface active agents, oils, waxes, and others), emulsions, emollients, lotions, topical medicines, soaps, various anti-microbial and anti-bacterial agents, and moisturizers (for example, glycols); fillers, such, for example, as clay slurry; a variety of resins; coatings, such, for example, as clay and latex, and various opacifiers; inks and dyes; binders; reactive and non-reactive vapors, such, for example, as oxygen and nitrogen.

One of the preferred chemical additives that can be beneficially used with the apparatus of the present invention comprises a chemical softening composition. More preferably, the chemical softening composition comprises quaternary compounds having the formula:



wherein:

m is 1 to 3;

each R₁ is a C₁-C₆ alkyl group, hydroxyalkyl group, hydrocarbyl or substituted hydrocarbyl group, alkoxyated group, benzyl group, or mixtures thereof;

each R₂ is a C₁₄-C₂₂ alkyl group, hydroxyalkyl group, hydrocarbyl or substituted hydrocarbyl group, alkoxyated group, benzyl group, or mixtures thereof; and

X⁻ is any softener-compatible anion

Preferably, each R₁ is methyl and X⁻ is chloride or methyl sulfate. Preferably, each R₂ is C₁₆-C₁₈ alkyl or alkenyl, most preferably each R₂ is straight-chain C₁₈ alkyl or alkenyl. Optionally, the R₂ substituent can be

derived from vegetable oil sources. Several types of the vegetable oils (e.g., olive, canola, safflower, sunflower, etc.) can be used as sources of fatty acids to synthesize the quaternary ammonium compound. Branched chain actives (e.g., made from isostearic acid) are also preferred.

Such structures include the well-known dialkyldimethylammonium salts (e.g. ditallowdimethylammonium chloride, ditallowdimethylammonium methyl sulfate, di(hydrogenated tallow)dimethyl ammonium chloride, etc.), in which R₁ are methyl groups, R₂ are tallow groups of varying levels of saturation, and X⁻ is chloride or methyl sulfate. Commonly assigned patent applications Serial Number 08/947,422, filed 10/8/97 in the name of Ficke, et al., and Serial Number 60/103,371 (provisional), filed 10/15/98 in the name of Vinson, et al. are incorporated herein by reference for the purpose of disclosing preferred softening chemical compositions.

Depending on a particular process, chemical additives may be added to papermaking fibers during formation of the paper web, or/and by applying the additive to one or both surfaces of the web after the web has generally been formed. If the chemical additive is to be applied to at least one surface of the web, it may be desirable to apply the additive, such as a softener, in such a way that the additive remains on the surface of the web and does not significantly penetrate the web's thickness. The present invention is primarily concerned with, but not limited to, applying the chemical additive such as a softener to the surface of the web substrate. Exemplary art includes U. S. Patent 5,215,626, issued to Ampulski, et. al. on June 1, 1993; U. S. Patent 5,246,545, issued to Ampulski, et. al. on September 21, 1993; U. S. Patent 5,525,345, issued to Warner, et. al. on June 11, 1996, and U.S. Patent application Serial No. 09/053,319 filed in the name of Vinson, et al. on April 1, 1998, all incorporated herein by reference.

The die head 10 further comprises a pair of mutually opposite discharge lips: a first lip 21 and a second lip 22. The first lip 21 has a first edge 21a, and the second lip 22 has a second edge 22a. The discharge lips 21, 22 are elongated elements extending in a widthwise direction **W** of the die 10, FIGs. 4-5. The discharge lips 21, 22 form at least one discharge mouth 20 therebetween, FIGs. 1, 2, 4, 5, and 6. The discharge mouth 20 is in fluid communication with the interior channel 25. In an embodiment shown in FIG. 4, the discharge lips 21, 22 form one elongated discharge mouth 20, extending in the widthwise direction **W**. In embodiments shown in FIGs. 5 and 6, the discharge lips 21, 22 having cavities, or "grooves" therein form a plurality of discharge mouths 20 consecutively spaced one from another in the widthwise direction **W**.

According to the present invention, at least one of the discharge lips 21, 22 is movable relative to the other of the discharge lips 21, 22. Preferably, at least one of the discharge lips 21, 22 is slidably movable in the direction substantially parallel to the direction of the chemical additive's flow through the discharge mouth 20. FIGs. 1 and 2 show that the first lip 21 is in operable communication with, and preferably connected to, lip actuator 30. As used herein, the term "lip actuator" refers to a device structured and designed to cause at least one of the lips 21, 22 to move in a direction substantially parallel to the direction of the chemical additive's movement through the discharge mouth 20. This direction is termed herein as "first direction" and designated by a symbol "**B**" in FIGs. 1 and 2. In the embodiments of FIGs. 1, 2, 2A, and 2B, the lip actuator 30 preferably comprises a shaft 39.

The lip actuator 30 may comprise a variety of devices. In FIG. 1, for example, the lip actuator 30 comprises a screw rotatably fixed to the body of the die head and to the first lip 21 such that as the screw rotates, it

causes the first lip **21** to move in the first direction **B**. In the embodiment shown in FIG. **2**, the lip actuator **30** comprises a piston. During operation, the piston is actuated by means of a pressurized fluid, such as hydraulics or pneumatics to induce a compressive force causing first lip **21** to move in a first direction **B**.

Other embodiments of the lip actuator **30** may include a device structured to move the lips **21** and **22** in relation to one another by energizing and releasing a spring **33** (FIGs. **2**, **2A**, and **2B**). In FIG. **2**, the shaft **39** is movable by a fluid pressure developed by a medium contained in a chamber **31**. Such a medium may comprise air or any suitable liquid. The spring **33** biases the shaft **39** against a wall of the chamber **31** when the fluid pressure is released. FIG. **2A** shows the lip actuator **30** comprising the shaft **39** in operative communication with a rotatable cam **32**. In FIG. **2B**, the lip actuator **30** comprises an electromagnetic, or magnet, device **34**. As the magnet device **34** is energized, it causes the shaft **39** to move to or from (depending on the embodiment) the device **34**. Other embodiments of the lip actuator **30** may utilize thermal expansion using heating or cooling devices, or micro-wave radiation, to induce tensile and compressive forces in lip actuator **30**.

It is believed that shearing forces created when lips **21** and **22** are moved relative to one another are effective at dislodging contaminants by increasing the force vector applied to the contaminant particle directed in direction **B**, in addition to the force created by the head pressure of the extrudable fluid in the discharge mouth **20**. This additional force is sufficient to induce the contaminant to overcome frictional or other forces binding the contaminant to one or both of the die lips **21** and **22**.

FIGs. **1** and **2** show an embodiment of the die **10** in which both the first and second lips **21**, **22** are also flexibly movable relative to each other

in the direction substantially perpendicular to the first direction **B**. The lips **21**, **22** in FIGs. **1** and **2** are flexibly adjustable such that the distance **D** between the leading edge **21a** and the trailing edge **22a** can be effectively controlled by a lip persuader **40** comprising at least one screw **41**, preferably having a fine-pitch thread, engaging a nut fixedly secured to the body of the die **10**. A face end of the screw **41** is abutting a shoulder formed at an opposite side of the lip **21** or/and **22**. When the screws **41** are rotated, their face ends extend forward and engage (and push) the respective lips **21**, **22** -- and consequently the edges **21a**, **22a** -- towards each other, thereby adjusting the distance **D** therebetween. Preferably, the lip persuader **40** comprises a plurality of the screws **41** and the corresponding nuts, equally distributed along the outlet width **W** -- to provide a necessary precision of controlling the distance **D** along the outlet width **W**, FIG. **4**. The screw **41** of the lip persuader **40** may be complemented by a heating device **45** (FIG. **1**), for a more accurate adjustment of the distance **D**. In the latter instance, a coarse adjustment of the distance **D** may be accomplished by rotating the screw **41** within the nut, and then a fine adjustment of the distance **D** may be made by heating the screw **41** which preferably causes a minimal and finely-tuned longitudinal expansion of the screw **41**. It is to be understood that depending on specific embodiments of the lip persuader **40** and the heating device **45**, the heating device **45** may be utilized for a coarse adjustment, while the screw **41** -- for a fine adjustment. It should also be understood that while FIGs. **1** and **2** show, for the illustration purposes, that the lip persuader **40** engaging both lips **21** and **22**, only one of the lips **21** or **22** may be made to be flexibly-adjustable.

In FIG. **5**, each of the plurality of the discharge mouths, formed by the first and second lips **21**, **22**, has a discharge orifice in the shape of a

circle. In FIGs. 5 and 6, the discharge mouths 20 are formed by semi-circular cavities, or "grooves," in at least one of the discharge lips 21, 22. Mutually opposite portions of the lips 21, 22, which portions are located intermediate the discharge mouths 20, contact, or abut, each other such as to form a seal therebetween. Preferably, a knife-edge tip 29 is formed in the areas of abutting portions of the lips 21, 22. One (upper) half of the discharge orifice is formed by a portion of the first lip 21, and the other (lower) portion of the discharge orifice is formed by the portion of the second lip 22. It is to be understood that while the circular/oval shape of the discharge orifice(s) is preferred, other shapes, for example, semi-circular (FIG. 6), oval (not shown) or rectangular (not shown), are also contemplated in the present invention.

The reference is made herein to the "machine direction" designated in FIG. 3 as a directional arrow "MD." As used herein, the term "machine direction" indicates a direction which is parallel to the flow of the substrate (or the working surface) 50 through the equipment. The term "cross-machine direction" (or "CD," not shown) indicates a direction which is perpendicular to the machine direction and lies in the general plane of the substrate or working surface 50. In some embodiments of the process according to the present invention, the cross-machine direction may coincide with the widthwise direction W of the die 10, FIGs. 4-6. Preferably, in the process of the present invention, the working surface 50 is continuously moving in the machine direction in front of the discharge mouth 20 of the die head 10, in a close proximity thereto. Depending on a specific process, the working surface 50 may comprise the surface of the web substrate, or a surface of a rotating roll which later comes into contact with the surface of the substrate thereby transferring the chemical additive thereto. The die head may also be used for making cast films or blown

What is claimed is:

1. A die head for extruding an extrudable material, the die head having an interior channel for receiving the extrudable material, the die head comprising a pair of mutually opposite discharge lips forming therebetween at least one discharge mouth in fluid communication with the interior channel, wherein at least one of the discharge lips is movable relative to the other in a first direction substantially parallel to the movement of the extrudable material through the discharge mouth.
2. The die head according to Claim 1, further comprising a lip actuator in operable communication with the movable discharge lip for controlling the movement thereof, wherein the lip actuator preferably comprises a screw, a piston movable by fluid pressure, a shaft in operable communication with a cam, a magnet device, or any combination thereof.
3. The die head according to Claims 1 and 2, wherein the discharge mouth is flared in at least one cross-section, and preferably in at least two mutually perpendicular cross-sections.
4. The die head according to Claims 1, 2, and 3, wherein the die head has a plurality of discharge mouths consecutively spaced one from the other.
5. The die head according to Claims 1, 2, 3, and 4, wherein at least one discharge lip further has at least one lip persuader in operable

communication therewith for moving said at least one lip in a second direction substantially different from the first direction.

6. The die head according to Claims 1, 2, 3, 4, and 5, further comprising a knife-edge tip formed by at least one of the discharge lips.
7. The die head according to Claims 1, 2, 3, 4, 5, and 6, wherein the at least one discharge mouth is formed by a cavity in at least one of the discharge lips, wherein mutually opposite portions of the discharge lips sealably abut each other.
8. A process for extruding a chemical additive used in making a disposable paper product, the process comprising steps of:
 - (a) providing a chemical additive, preferably selected from the group consisting of softeners, emulsions, emollients, lotions, topical medicines, soaps, anti-microbial and anti-bacterial agents, moisturizers, coatings, inks and dyes, and binders;
 - (b) providing a die head having an interior channel for receiving the chemical additive, the die head comprising a pair of mutually opposite discharge lips forming therebetween at least one discharge mouth in fluid communication with the interior channel, wherein at least one of the discharge lips is movable relative to the other in a first direction substantially parallel to the movement of the chemical additive through the discharge mouth;
 - (c) extruding the chemical additive through the discharge mouth of the die head; and

- (d) moving, from time to time, at least one of the discharge lips, thereby removing contamination build-ups in the discharge mouth.
9. The process according to Claim 8, further comprising a step of providing a working surface and continuously moving the working surface in front of the discharge mouth of the die head, whereby the step (c) further comprises depositing the extruded chemical additive onto the working surface.
10. A process for applying a softening composition to a surface of the substrate, the process comprising steps of:
- (a) providing a softening composition selected from the group comprising polysiloxane, cationic and non-cationic surface active agents, and mixtures thereof;
 - (b) providing a die head comprising a pair of mutually opposite discharge lips forming therebetween at least one discharge mouth, wherein at least one of the discharge lips is movable relative to the other in a first direction substantially parallel to the movement of the softening composition through the discharge mouth;
 - (c) providing the substrate and continuously moving the substrate in front of the discharge mouth of the die head;
 - (d) supplying the softening composition into the die head and extruding the softening composition through the discharge mouth of the die head onto the substrate; and

- (d) moving, from time to time, at least one of the discharge lips of the die head, thereby removing contamination build-ups from the discharge mouth of the die head.

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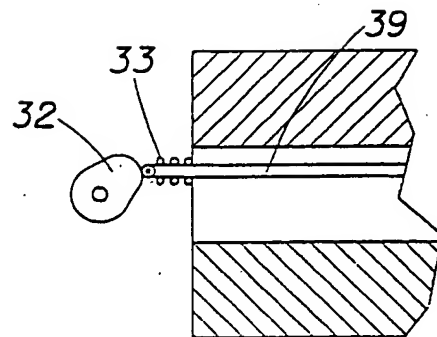


Fig. 2A

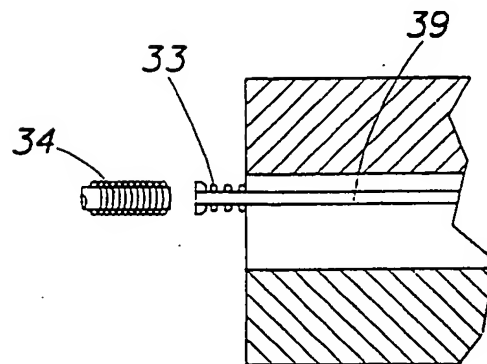


Fig. 2B

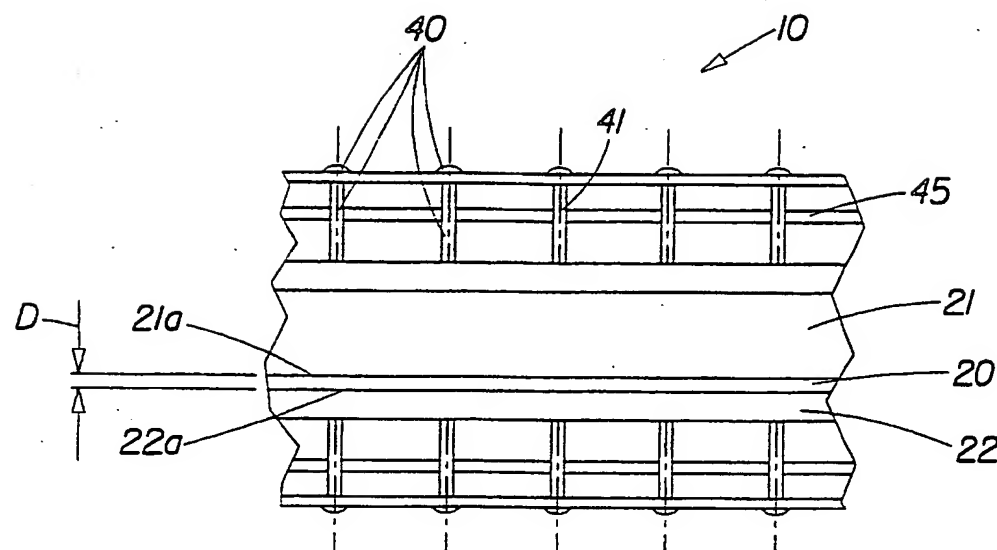


Fig. 4

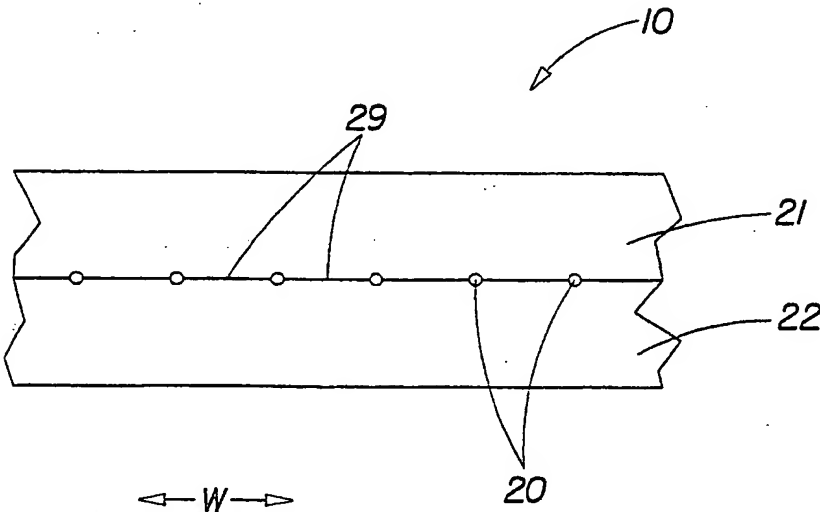


Fig. 5

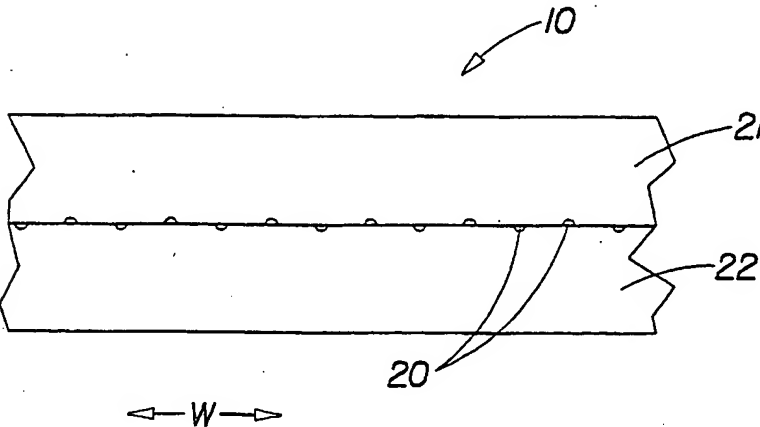


Fig. 6

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29C47/16 A61F13/00 B05C5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29C A61F B05C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 195 47 658 A (VOITH SULZER PAPIERMASCH GMBH) 26 June 1997 (1997-06-26) abstract; figures 1,2 ---	1-10
A	EP 0 329 424 A (KONISHIROKU PHOTO IND) 23 August 1989 (1989-08-23) abstract; figures 1-3 ---	1-3,8,10
A	US 5 522 931 A (IWASHITA HIRONOBU ET AL) 4 June 1996 (1996-06-04) cited in the application the whole document --- -/--	1,8,10

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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